argues that the existing distribution of land is so extremely irregular—such an undue proportion being near the poles, while there is such a deficiency at the equator and in the south temperate zone—that whatever differences may have occurred in past time, they can hardly fail to have often been such as to cause a more uniform climate. Therefore he believes that if the poles were tolerably free from land, so as to admit of the uninterrupted circulation of the warmer equatorial waters and to afford no lodgment for great accumulations of snow and ice, a glacial epoch would be impossible even during the most extreme phases of excentricity.

We have now much evidence to show that three distinct modifications in physical geography occurred just before or during the Glacial epoch, which would each tend to lower the temperature. The first is the submergence of the Sahara, which would have caused the southerly winds to be charged with aqueous vapour, condensing on the Alps into snow instead of being, as now, dry and heated and acting powerfully to melt the glaciers. The second is the submergence of Lapland, which would have admitted the cold iceberg-laden waters of the Arctic Sea into the very heart of Europe. The third is the probable submergence of part of Central America, causing the Gulf Stream to be diverted into the Pacific. The only proof of this is the fact that one-third of the known species of marine fishes are absolutely identical on the two sides of the isthmus of Panama; but it is impossible to conceive any means by which such an amount of identity could have been brought about except by a recent, if only a temporary, communication. A subsidence and elevation no greater than what occurred in Wales about the same time—as proved by Arctic shells of existing species in drift 1,300 feet above the sea—would have effected the communication by a broad and deep channel. Now if any two of these changes of physical geography occurred together, we may be sure that a very small increase of excentricity would have led to a more severe glacial epoch than would be possible, under existing conditions, with a much larger excentricity. We must keep this in mind when attempting to fix the most probable date for the last glacial epoch. A. R. WALLACE

FARADAY

The Life and Letters of Faraday. By Dr. Bence Jones. Two vols. 8vo. (Longmans, 1869.)

IF none but Apelles was fit to paint Alexander, where shall we find a biographer worthy of Faraday? Shortly after his death, many sketches of his character and work appeared, among which that of De la Rive may be specially mentioned. These were succeeded by Tyndall's two Friday evening discourses on "Faraday as a Discoverer," which were afterwards embodied in an admirable little book. But a more complete biography was wanted, and the question was frequently asked, "Who understood him sufficiently well to draw his portrait?" Eventually it was rumoured that the materials had been placed in the hands of Dr. Bence Jones. First there appeared an unusually long obituary notice in the Proceedings of the Royal Society, consisting of little else than a catalogue of the papers published, lectures delivered, reports written and honours won by the great philosopher in each year during half a century; showing that Dr. Jones had a rare collection of interesting documents, so as to whet our appetite for the coming work. Now it is before us—"The Life and Letters of Faraday" —in two goodly octavo volumes.

The preface tells us what we are to expect: not a complete likeness either of the man or of the philosopher; but a kind of "autobiography"—for, as the author truly says, "from his letters, his laboratory note-books, his lecture-books, his Trinity-house and other manuscripts, I have arranged the materials for a memorial of Faraday in the simplest order, with the least connecting matter." The very abundance of that material was a source of embarrassment, and the necessity for omissions seems to have been felt more strongly as the work advanced; so that while very nearly half the first volume is devoted to three years of Faraday's life—when he was between twenty and twenty-three years of age and before his "earlier scientific education at the Royal Institution" commenced—the latter years of his life are so rapidly passed over, that some of his latest scientific work—for instance, the adjustment of apparatus in lighthouses—is not even alluded to.

An autobiography has great advantages, especially when it is, as in this instance, an unconscious one; but it is not without its defects. It gives a picture only from one point of view, and Faraday was too modest always to do himself justice. We want to know what impressions other people formed of him, and those who have enjoyed his company would wish to find, in the book, some reflex of his own brightness, some of those characteristic anecdotes which are told in scientific circles. The best, almost the only sketch of this kind in the book, is by one of his nieces, Miss Reid, who gives charming details of her uncle's treatment of her when a little girl, and of his habits both at work and play. Tyndall's book, though professing to describe Faraday only as a discoverer, gives a far more vivid impression of the man. I propose at some time to write down my own reminiscences of him; but at present there is not room to deal with more than the way in which he is presented to the world in the "Life and Letters."

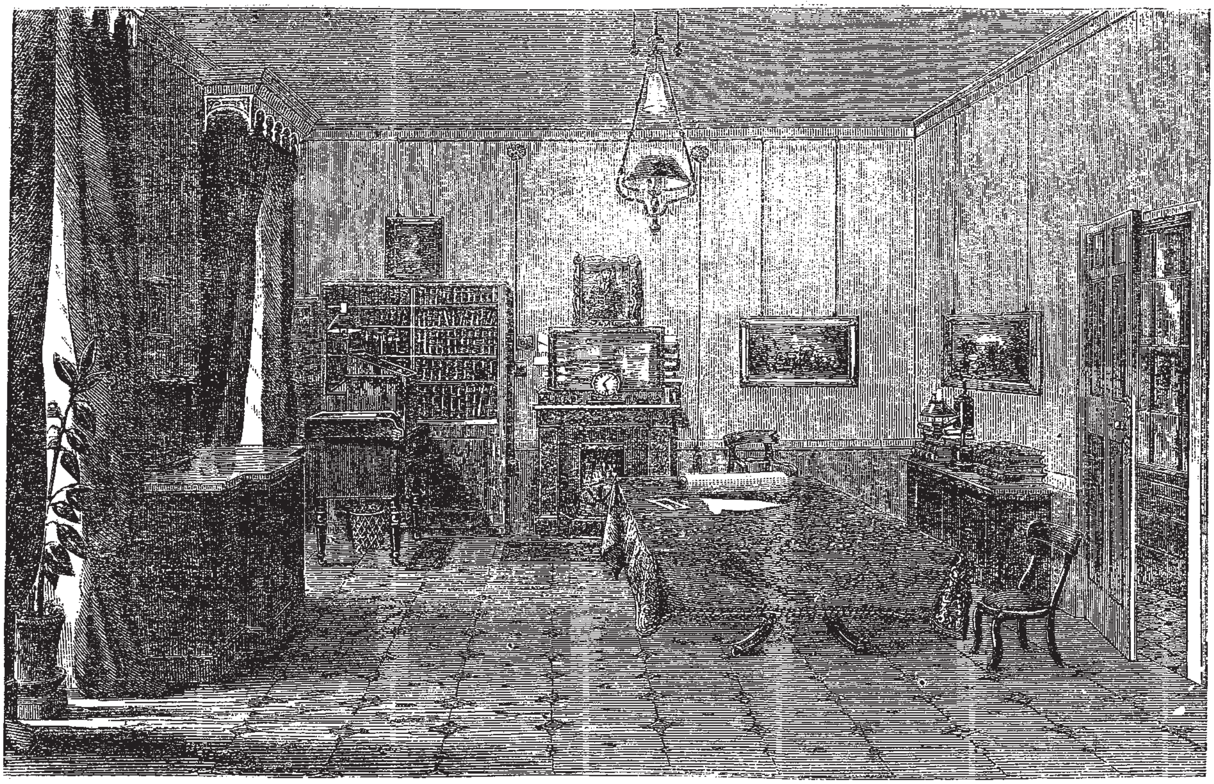
The career of Michael Faraday was marked by steady progress rather than by striking events; there were few changes in his life save such as rose naturally from his increasing knowledge and ever-growing fame. We find him born in London in 1791, of poor parents, taught little more than the rudiments of reading, writing, and arithmetic; beginning active life as an errand-boy at a bookseller's in Blandford Street, and shortly afterwards apprenticed to a bookbinder. Here, however, we see him taking every opportunity of gaining knowledge, making experiments in natural science, and presently, on introducing himself to the notice of Davy, obtaining the post of assistant in the laboratory of the Royal Institution. That was in March 1813. His travels with Sir Humphrey about the Continent, for a year and a half, are minutely described in copious extracts from his diary and his letters home: we see here how he came into contact with many other bright intellects, and learned what to copy and what to avoid. In 1816, at the City Philosophical Society, he gave his first lecture, and, in the *Quarterly Journal of Science*, he published his first paper —on native caustic lime—the beginning, in each case, of a series which for many years delighted and instructed his contemporaries. In 1821 commenced his happy domestic life, through his marriage with Miss Sarah

Barnard. Immediately afterwards he became a member of the Sandemanian Church, in which eventually he held the office of elder, and frequently preached. When he was appointed Director of the Laboratory at the Royal Institution, in 1825, his first act was to invite the members to evening meetings with experimental demonstrations, thus commencing the Friday evening discourses, while in the same year he started the juvenile lectures at Christmas. Eight years afterwards he was appointed Fullerian Professor of Chemistry. He continued to discharge these various duties at Albemarle Street till failing health rendered it impossible. During this time we see Faraday working often for the Government and regularly for the Trinity House, while the researches in his laboratory were never intermitted, except through illness. To enumerate his investigations here would be out of the question, but all students of science will remember something of what he accomplished in the liquefaction of gases, the preparation of steel and optical glass, the ventilation of lighthouses, and, especially, that magnificent series of researches in electricity which extended from 1831 to 1855, comprising the induction of electric currents, the evolution of electricity from magnetism, the explanation of the voltaic pile, with the definiteness of electro-chemical decomposition, the influence of magnetism on a ray of polarised light, diamagnetism, the polarity of bismuth and other crystalline bodies, the effect of heat on magnetic force, as well as the mutual relation of these various powers of nature.

These discoveries were made known principally in the "Philosophical Transactions," extending his reputation so much that, though living in great simplicity, his friendship was desired by the great as well as by the wise of the earth. He received unsought no fewer than ninety-five honorary titles and marks of merit, while both the Royal Society and the Royal Institution in vain requested him to become their president.

The book consists in a great measure of Faraday's own words; to a few intimate friends, as Mr. B. Abbott, Huxtable, his wife, Schönbein, and De la Rive, both father and son, he poured out his thoughts in a rich stream. From these various writings it is very tempting to make extracts. Here are two or three :—

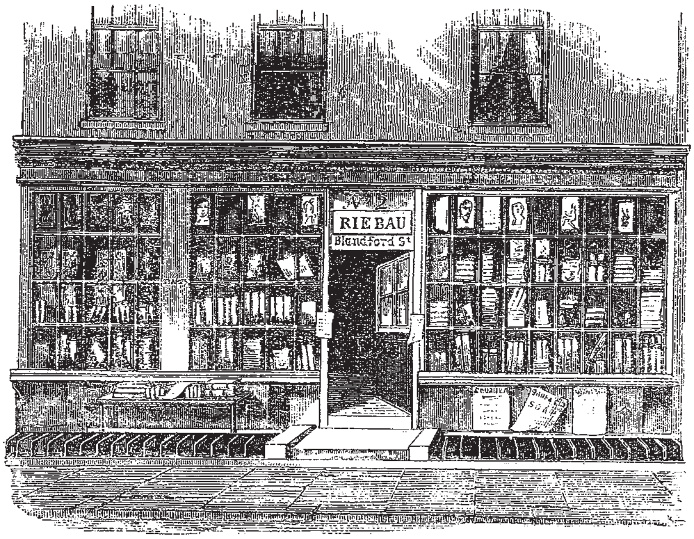
"The philosopher should be a man willing to listen to every suggestion, but determined to judge for himself. He should not be biassed by appearances; have no favourite hypothesis; be of no school and, in doctrine, have no master. He should not be a respecter of persons, but of things. Truth should be his primary object. If to these qualities be added industry, he may indeed hope to walk within the veil of the Temple of Nature."



FARADAY'S ROOM AT THE ROYAL INSTITUTION

"When a mathematician engaged in investigating physical actions and results, has arrived at his own conclusions, may they not be expressed in common language as fully, clearly, and definitely as in mathematical formulæ? If so, would it not be a great boon to such as we to express them so—translating them out of their hieroglyphics that we also might work upon them by experiment? I think it must be so, because I have always found that you could convey to me a perfectly clear idea of your conclusions, which, though they may give me no full understanding of the steps of your process, gave me the results, neither above nor below the truth, and so clear in character that I can think and work for them."

"I do think that the study of natural science is so glorious a school for the mind, that with the laws impressed on all created things by the Creator and the wonderful unity and stability of matter and the forces of matter, there cannot be a better school for the education of the mind."



BOOKSELLER'S SHOP IN BLANDFORD STREET WHERE FARADAY WAS APPRENTICED

For giving us this correspondence we owe no small debt of gratitude to Dr. Bence Jones, who has also enriched the biography by letters which Faraday received on various occasions from many eminent men. In conclusion he enumerates what he conceives to be the chief characteristics of the subject of his memoir: as a philosopher, the trust which he put in facts, and the power of his imagination,—as a man, truthfulness, kindness, and energy. He speaks also of the great influence of religion on his character.

To form a complete conception of Faraday we must picture him calmly, patiently, and honestly asking questions of nature in his laboratory, and following up the intuitions of his genius; now chatting with his friends in a strain of kindly sympathy or genial playfulness, then giving forth the results of his own or others' discoveries to large and rivetted audiences with perfect simplicity of thought and language; experimenting before them with marvellous dexterity; writing learned papers and inventing useful applications; but ever enriching mankind both by the wealth of his discoveries and the beauty of his example.

J. H. GLADSTONE

OUR BOOK SHELF

Sorghum and its Products.—*An Account of recent Investigations concerning the Value of Sorghum in Sugar Production, &c. &c.* By F. L. Stewart. (Lippencott: Philadelphia. 8vo. 1869. London: Trübner.)

MR. STEWART informs us that sorghum was introduced in 1854 into the United States from France, whither it had been carried from China. It is now grown on a large scale and quite successfully, in North America. The little treatise now before us is intended as a manual for the manufacture of syrup and sugar from this plant: the author has divided his work into thirty chapters, treating consecutively of the history and cultivation of the sorghum, the extraction of sugar from it and the mode of utilising the various waste products obtained.

Mr. Stewart's manual may be read with interest, not only by manufacturers—who will find it most practically written—but by all who feel a pleasure in the success of economic chemistry. The author does not, however, carry his description so far as the final stage of a finished process. He seems to have contented himself with writing merely for farmers of about 75 acres, and instructing them how to prepare on their own land "a golden syrup, unexcelled either in colour or flavour by the best products of the refineries" (p. 153), or "a fair yellow sugar." This is not the proper condition of a great national industry. The successful manufacture of sugar, indeed, can hardly be attained without the concentrated effort of a large capital, aided, even then, by considerable special knowledge. The class of cultivators described by the author would consult their own advantage by contenting themselves with the humbler office of contributing the raw material.

Vegetable Essences.—*Die Pflanzenstoffe* in chemischer physiologischer, pharmakologischer, and toxicologischer Hinsicht. Bearbeitet von Dr. Aug. Husemann und Dr. Theod. Husemann. Erste Lieferung; Bogen 1—16. (Berlin: Springer, 1870. London: Williams and Norgate.)

THE first section of an important work on those products of the vegetable kingdom which are of importance to the chemist, the physiologist, and the physician. These substances the MM. Husemann classify as follows:—A, Simple combinations; (1) Bases or alkaloids; (2) Acids, both those of general distribution and those of special development; (3) Neutral substances, with the same distinction. B, Compound substances; (1) Volatile oils; (2) Resins; (3) Fats. In each section the substances are arranged under the natural orders to which the plants belong; and we have an account of their discovery, mode of preparation, properties, composition, products of decomposition, behaviour with various reagents, and physiological and toxological effects. The present part does not exhaust the alkaloids.

A. W. B.